Food Supply System in Wuhan Under COVID-19: An Evolutionary Perspective Based on Informality

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Abstract:

The sudden outbreak of COVID-19 has caused a severe impact on Wuhan’s food supply system. Wet markets that used to cover more than 70% of the need for fresh food in Wuhan were shut down. Food circulation was blocked, and the problem of mismatch between supply and demand has raised widespread concerns. Although the government took bunches of measures (including the designated supermarkets, grid management of communities), the everyday life of Wuhan citizens and other people stranded here was greatly affected. Not being able to get out due to the control policy and buy whatever they want as before, people in Wuhan found it extremely hard to obtain fresh and varied food. Some of them were even unable to maintain a basic life. While at the same time, the informal organizations played essential roles in food supply chains, including spontaneous group-buying based on WeChat, the emerging e-commerce platforms. Increasing subjects were participating in the whole network, either for self-help or mutual assistance. The improvement to the entire system is more significant than the potential conflicts.

Based on this background, our research focuses on the food supply system in Wuhan during COVID-19, employs NVIVO to encode news reports related and other web texts. Three stages were summarized as the market order imbalance, government guidance failure, and informal organization participation. The research explored how formal forces and informal organizations have been interacting and complementing each other at the different stages of COVID-19. Through mode induction and mechanism interpretation, it builds a framework for evaluating the food supply system’s capacity under emergencies based on critical factors such as system supply, conversion capability. Moreover, our study provides reflections and suggestions for the food supply chains in the post-pandemic forwards.

Furthermore, through the analysis above, this paper also tries to propose universal optimization strategies for ensuring and stabilizing the local food supply system for megacities like Wuhan. The resilience of the food supply systems can be significantly improved through providing informal institutional space, promoting the effective interactions of formality and informality in the face of emergencies, and carrying out transforming wet markets, which can eventually achieve sustainable goals.
1 Introduction

Supply chain refers to the process of production and circulation, involving the product or service provided to the network’s end-user. The food supply chain is an integral whole composed of the economic interest subjects from the primary producer to the consumer, including the food supplier at the front end and the government as the regulator at the back end. Supply chain management has become a mature research field. In recent years, there has been an increasing body of research focusing on food safety, sustainable food supply, while the growing interdisciplinary research has promoted the development of food supply research in the sociology dimension. For example, Carter (2008, 360-387) has developed an elaborate framework to introduce sustainability into the field of supply chain management and delved into the relationships among environmental, social, and economic performance within a supply chain management context. Meanwhile, the management of food distribution networks is receiving more and more attention; most researchers in this field agree that consumers increasingly wish to be informed about the safety of their food, its origin, and the sustainability of the processes that have produced and delivered it (Akkerman, Farahani, and Grunow 2010; Aung, Chang 2014). Sustainability comprises environmental issues, social issues, and expected returns (Wognum et al. 2011; Beske, Land, and Seuring 2014). A few studies have shown that a challenging task in today’s food industry is to distribute high-quality perishable foods throughout the food supply chain (Govindan et al. 2014; Genovese et al. 2017). Yuan (2006) analyzed the investigation data of inhabitant fresh food consumption in Wuhan by SPSS, investigated the influential factors on the consumers’ choice of terminal channels for fresh food, and analyzed the characteristics of the selected groups of "supermarket" and "terminal-market".

An acute respiratory syndrome disease (COVID-19) began spreading globally at the end of 2019 (Lai et al. 2020; Zhou et al. 2020), and the World Health Organization declared it a pandemic on 11 March 2020 (Sohrabi et al. 2020; World Health Organization 2020). Being the first affected area, the Wuhan government took swift measures and decided to shut down the whole city after some adjustment (Lau et al. 2020; Prem et al. 2020; Tian et al. 2020). Looking at the closure of Wuhan and the pandemic outbreak, emergencies deeply affected the supply chain (Shareef et al. 2020), while the low degree of localization and insufficient resilience of the supply system aggravated the extent of the disaster (Pitt et al. 2017). In today's world, the material exchange is unprecedentedly frequent (Seowon 2012). Consequently, building a stable and sustainable food supply system is not merely about system design (Turken et al. 2020), while improving the level of food localization will not play an important role either (Jarzebowski et al. 2020). The evolution of the food supply system in Wuhan during the pandemic provides an excellent example for investigation: how the acting subjects in the order interact with each other and what benefits can derive from this interaction to maintain the stability of the food supply system. As the top-down design forms the structure (Petersen, Charman, and Kroll 2018), the new organization style arising from the interaction between acting subjects creates micro-channels that bridge and bond with each other under the massive structure, thereby increasing the integrity and stability of the entire system.

A closer examination of the food supply system in Wuhan under the pandemic revealed that aside from various measures the government took, the informal organizations played significant roles as well, including online tools such as spontaneous group-buying on WeChat, and the emerging e-commerce platforms, and such online tools. With the development of the pandemic, increasing subjects were participating in the whole network, either for self-help or mutual assistance.
Conflicts did take place, yet the improvement for the entire system is even more critical. This kind of bottom-up forces or behaviors can be conceptualized into ‘Informality,’ which arises spontaneously due to unmet needs without government intervention (Koch 2015; Kazembe, Ndeyapo, and Jonathan 2019).

Under this background, this paper adopts the technical method of coding with NVIVO, which is a powerful tool that can facilitate many aspects of the grounded theory process from the design and early sampling procedures (Hutchison, Johnston, and Breckon 2010; Leech and Onwuegbuzie 2011). Taking the perspective of informality, this research investigates the characteristics and changes of the food supply system in Wuhan under the pandemic. On this basis, this paper hopes to provide prescriptions conducive to the construction of sustainable food supply chains or systems. Specifically, the period selected by the study is January-April 2020; data sources include news reports, public account tweets, and Weibo posts that can be retrieved during this period.

2 Food supply system during COVID-19

The original food supply system in Wuhan had two characteristics: first, in supply chains, wet markets played a dominant role; second, the localization level was not high (Huang, Li, and Xu 2014). By the beginning of 2020, there were about 400 traditional wet markets in Wuhan, while their retail sales accounted for 70-80% of the whole city's market share. From the perspective of spatial distribution, wet markets drew even in urban areas and surpassed supermarkets in peripheral suburban regions (see Fig. 1).

During the pandemic, the original food supply system could no longer function smoothly and maintain stability. Although the government positively participated in food supply guidance, in such case of emergency and attempted to maintain the original market order, the complexity and diversity of the system eventually resulted in a shift from “market order imbalance” to “government intervention failure” to “informal organization participation”. This transmutation showed a trend of more democratic and independent management under the pandemic environment.

2.1 Market order imbalance

The closure of the wet markets was due to the risks of heavy traffic and ineffective supervision, which promptly disrupted the whole supply chains. In light of workforce shortage, control policies,
and higher transportation costs, supermarkets were forced to inflate prices and undersupply. Furthermore, supermarkets could not diversify to meet citizens’ demands easily and left the public with the impression that food and vegetables were not “fresh” enough. For the above reasons, it was hardly practical to substitute supermarkets for wet markets expeditiously.

On the supply side, the situation was worsened in a lack of wet markets as intermediate nodes. Vegetable retailers and food wholesalers lost their fixed sales channels. Meanwhile, traffic control in and out of the city caused a considerable number of vegetables, eggs, aquatic, and other agricultural products from Wuhan’s local production bases seriously unmarketable. On the demand side, the number of residents who went to the supermarkets for shopping surged, which caused more residents to panic buying and increased the probability of cross-infection.

2.2 Government intervention failure

After the market imbalance, the government quickly stepped in and made efforts in two ways successively: the “government-guided road markets” to maintain the market order, and the “planned community distribution” to construct a stable order.

The government-guided road markets were an attempt by the government to temporarily maintain the wet markets order and relieve the tension between supply and demand, by arranging vendors and retailers to trade at designated locations such as open spaces, squares, roadways, and alleys. The Municipal Bureau of Commerce took the lead to organize the wholesaler to ensure the supply and transport vehicles. Before, the Ministry of Commerce issued an emergency document to support road markets on February 17 officially. Afterward, multiple local government departments, such as the commerce bureau, market supervision department, health and disease control department, cooperated in governance and market order maintenance. In practice, road markets proved itself feasible and effective as road markets were well ventilated, publicly accessible, and public satisfaction is generally high.

Despite a brief success, the road market method was abandoned due to security reasons and management difficulty under the pandemic. Then the government turned to a plan-based approach to direct community food distribution.

The planned community distribution referred to the community's approach to collecting data on residents’ daily needs and directly delivering the food from the government to all residents. This approach gave up the market order and later arose two difficulties in practice: (1) The supply was
relatively narrow due to the complicated supervision procedures and systematic management methods. (2) It was challenging to fulfill residents' requirements due to the high pressure of the statistic work like data collection and the lack of freedom to choose products.

2.3 Informal organization participation

Given the fact that both market and government forces were ineffective, residents transformed the community online information group and other WeChat group temporarily to carry out food supply and distribution. Residents, property owners, retailers, communities, and other parties established informal food supply organizations based on "acquaintance", in which all members and volunteers elected "leaders" recruited to connect suppliers and communities (See Fig. 4).

Compared with the above approach, informal organizations show several advantages. Firstly, they could provide precise and flexible feedback on requirements, "delivered every day and delivered today". Secondly, by eliminating intermediate links, they restored the autonomy of food producers, wholesalers, and retailers. Thirdly, volunteers' participation made up for the administrative instruction delay and facilitated the precise positioning of food distribution. Lastly, community residents take advantage of the space in the community square, the open space in the building, and the property entrance to get vegetables together and conduct food exchange, promoting the neighborhood awareness and the stability of the supply chain.
The entire evolution process can be summarized in Table 1.

<table>
<thead>
<tr>
<th>Process</th>
<th>Government intervention failure</th>
<th>Direct distribution in planned communities</th>
<th>Informal organization participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenomenon</td>
<td>Panic buying</td>
<td>Government-guided road market</td>
<td>Government-guided road market</td>
</tr>
<tr>
<td>Reason</td>
<td>1. Wet markets closed; 2. Supermarkets' weak substitution capabilities; 3. Traffic control;</td>
<td>Normal market order imbalance</td>
<td>Road market failure</td>
</tr>
<tr>
<td>Pattern</td>
<td>Supply</td>
<td>Ease the contradiction</td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td>Supermarket</td>
<td></td>
<td>Supervise</td>
</tr>
<tr>
<td></td>
<td>Wet market</td>
<td></td>
<td>Guide</td>
</tr>
<tr>
<td></td>
<td>Under-supply</td>
<td>Road market</td>
<td>Purchase</td>
</tr>
<tr>
<td></td>
<td>Closure</td>
<td>Convenient</td>
<td>Community</td>
</tr>
<tr>
<td></td>
<td>Panic buying</td>
<td>Feedback</td>
<td>Staff</td>
</tr>
<tr>
<td></td>
<td>Inflated price</td>
<td>Risk of cross-infection</td>
<td>Feedback</td>
</tr>
<tr>
<td></td>
<td>Various</td>
<td>Fresh</td>
<td>Residents</td>
</tr>
<tr>
<td>Demand</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### 3 Organization modes and evaluation

#### 3.1 Differentiation of supply and demand

Affected by the pandemic outbreak and Wuhan lockdown, the food supply system suffered a significant impact from the shutdown of the wet markets, followed by the cut off of intricate microchannel, finally leading to a supply side and demand side differentiation.

Specifically, there were three primary food sources on the supply side: wholesale suppliers with long-term cooperation with Wuhan first-level wet markets, donations from other regions, and vegetable and fruit bases in Wuhan suburban areas.

1. The wholesale channels were severely blocked at the beginning of the pandemic. Most wet markets were closed, and goods circulation and traffic were significantly reduced compared with the same period in previous years. 2. The donations from other regions played a pivotal role in the Wuhan food supply systems from the end of January to the beginning of February. Mainly allocated by the government, donations were either supplemented as a guarantee for the needy people or entered markets to stabilize vegetable prices. 3. Local suburban vegetables and fruit bases gave full play to the middle and late pandemic stages of the food supply role. Through various selling platforms, food production based alleviated unsalable pressure while supporting normalized pandemic control and directing more frequent and in-depth interactions between the supply and demand in the later stages of the pandemic.

On the demand side, according to the organization structure and capacity, demanders could be
divided into **highly-organized (A)**, **self-organized (B)**, and **out-of-the-system (C)**. Highly-organized demanders were workers in necessary production departments during the pandemic, medical workers in medical institutions (including assisting medical teams from other provinces), and people in quarantine. Since the food for highly-organized demanders was administratively distributed, this study mainly explored self-organized and outside-organization demanders.

The self-organized demanders were mainly urban community residents who can spontaneously form a collective and choose whether to join the self-organized collective. During the pandemic, through online communication and offline distribution, these demanders created a relatively independent food supply method independent of government organizations.

The out-of-the-system demanders are those who are temporarily or permanently outside the above organization. People stranded in Wuhan are workers who usually live in communities or factories. The closure of factories and the lockdown of Wuhan prevented them from returning to their hometowns, leaving them nowhere to live. Moreover, tramps were permanent outside-organization demanders. The outside-organization demanders were directly connected with the government for resettlement through the rescue channel. In this process, government organizations played a leading role, and non-governmental organizations provided supplies to assist them.

![Diagram of food supply system](image)

**Fig.5 Differentiation of food supply system**

### 3.2 Driving force of evolution

The fundamental driving force behind the changes mentioned above in the food supply system in Wuhan under the pandemic lies in the interaction between supply and demand. The impact of the epidemic forced the original intricate supply network to be separated and simplified, and there was a clear differentiation between supply and demand. On the one hand, microchannel that used to be accidental and uncertain, such as buying vegetables from local households in suburban areas, were forced to cut off, and the obstruction of logistics caused difficulties in the purchase channels of large markets and supermarkets. On the other hand, the simplified supply and demand sides still found a great challenge to match each other, and the phenomenon of insufficient supply was surprisingly widespread. Under such circumstances, the divided supply and demand sides were motivated to act to bridge the gap. Furthermore, this has been the root cause of the interaction between supply and demand and the subsequent series of changes.

From the interactive network of the food supply (see Fig. 6), there were relatively few entities,
and conflicts were rather frequent at the beginning of the epidemic. The government also began to designated supermarkets at that time. Under the closed management of the community, most residents could only purchase fruits and vegetables through online platforms and entirely relied on community staff for unified purchase and unified delivery. Designated supermarkets, community staffs, properties, and community residents who can only receive supplies, were almost all the leading players in the food supply network at the beginning of the outbreak. Conflict incidents at this stage included gatherings to buy fruits and vegetables late at night (ignoring the control policies), complaints about high prices and tying behaviors, and so on. With the development of the epidemic, the number of network entities has increased significantly, and a large number of actors have emerged from the bottom up, such as volunteers, enthusiastic owners, and shopkeepers of small community supermarkets. Although there still exist some conflicts in the interaction between top-down and bottom-up forces, obtaining essential life commodities has been significantly resolved, and the intervention of multiple subjects has made the conflicts in the communication bridged. As the central bodies increased, the channels have become remarkably diversified (including the construction of agricultural products' direct selling platforms and other arrangements), and the food that people in Wuhan were able to obtain were much more abundant as well.

![Interactive Network of Food Supply](Fig.6)

### 3.3 Evaluation of three organization modes

For the highly organized demanders like doctors and workers (mode A) producing necessities of life, they did not have to worry about getting food. The government is utterly responsible for their meals, and there are almost no problems with their daily lives.

The core factors of evaluating mode B (self-organized) include three aspects: system supply, credible promise, and supervision. System supply means creating a system where individual games can benefit the collective, specifically, a system that can reach win-win situations where food suppliers obtain suitable profits with residents' needs met. Credible promise refers to the conditions when individuals can faithfully fulfill the obligations in the crowd. In a community-based acquaintance
society, trust among residents may become a guarantee of credible promises. Supervision is to monitor whether the collective follows the rules, including internal supervision that may happen in mutual ways through WeChat groups and external supervision from the government. Moreover, external supervision's strength is positively related to the degree of formality of the supply model.

Demanders in mode C (out-of-the-system), mostly people stranded due to the lockdown policy, were accidentally moved out of the conventional food supply system. Conversion capability and the fairness of supply are among the top concerns when evaluating mode C. Rapid conversion means converting to another mode of organization in a highly autonomous way. For example, if there were quite a few stranded people, local communities may (be requested to by superior government) take them in, and they became in mode B (self-organized) correspondingly. If there were only several stranded ones, the government might provide resettling assistance directly, and they grew in mode A (highly-organized) alternatively. Fairness includes the fairness in the selection of rescued groups, the distribution of funds and the distribution of services, whether there is a situation that meets the rescue conditions yet not in the rescue list and vice versa.

The critical factors for evaluating these three modes can summarize in Table 2. In the face of emergencies, the differentiation of both supply and demand sides is the most conspicuous feature of the whole food supply system. Since the limited resource should be allocated effectively enough in emergencies, the differentiation has its inherent logic and can also quickly mobilize the overall vitality of the food supply network. For those highly organized (mode A), the direct allocation is the most efficient way that enables them to obtain basic daily food. For the self-organized demanders (mode B), policy-making pays the most attention to providing space for self-organization, ensuring the effectiveness of credible promise and implementing supervision. For mode C, the food supply system should be able to rapidly convert to other modes to achieve high accessibility and fairness for life’s necessities.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Supply side</th>
<th>Demand side</th>
<th>Key factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode A</td>
<td>government</td>
<td>medical institutions/other organizations' staff, volunteers</td>
<td>basic guarantee</td>
</tr>
<tr>
<td>Highly-organized</td>
<td>supermarkets/wet markets</td>
<td>community residents</td>
<td>system supply, credible promise, supervision</td>
</tr>
<tr>
<td>Mode B</td>
<td>government</td>
<td>people stranded in Wuhan, tramps</td>
<td>conversion capability, fairness</td>
</tr>
<tr>
<td>Self-organized</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mode C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-of-the-system</td>
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### 4 Discussion

#### 4.1 Provide institutional space for informality in the food supply system

How to build a more resilient, stable, and sustainable urban food supply system under normalized pandemic prevention and control? Taking Wuhan as an example, we have seen how vital the informal forces' role could be in the process of the food supply system's return to stability. The everyday behaviors include small-scale group purchases of commodities spontaneously organized based on WeChat groups and larger-scale direct marketing platforms for agricultural products that emerged in the middle and late stages of the pandemic. There are hardly any government
interventions or official organizations; informality is born to be spontaneous, flexible, and able to meet real needs.

The road market is one of the most intriguing phenomena in terms of informality. In previous studies, the road market could be almost regarded as a representative of urban informality and needs to be rectified. However, the road markets in Wuhan have gone through a rather tortuous path. The sudden outbreak firstly caused most farmer's markets to shut down. Then in early February, the government announced to encourage the development of road markets to ensure that citizens were able to buy fresh fruits and vegetables. As the pressure of prevention and control continued to increase, a late-night incident where residents gathered to purchase fruits and vegetables forced the government to resolve to close the road market completely in late February. The repetition failed to solve the real problem, nor did it correctly guide the spontaneous activities. After the road markets were completely closed, the citizens in Wuhan could only order food via group purchases from designated supermarkets. Complaints flourished until March about price, quality, and inability to meet individual needs.

How will the institutional space for similar informal activities be planned and how to provide practical guidance when they appear? Perhaps a more secure and stable urban logistics system (meeting higher pandemic prevention standards) and more profound governance innovation at the grassroots level will be two directions worth exploring.

4.2 Future possibilities of reforming wet market

From the case of Wuhan, we can also see that no matter in normal life or under the pandemic situation, the wet market that sells vegetables, meat, eggs, fish and shrimp, and other agricultural products still occupies an indispensable and essential position in today's Chinese cities. It is not something that supermarkets can easily replace. The government used to make attempts to solve the problems of cities' appearance by completely transforming the wet market into a supermarket, but there has not been a complete success case. We do like to pick and choose fresh ingredients that we want in a bustling environment. However, the reform of the wet market in China is imperative. Otherwise, it will not be able to adapt to the requirements of continuous improvement of the urban environment, and it will not be able to play its due safeguard role in the face of public health emergencies such as COVID-19. On the contrary, it will become a representative of a mess and even a drag.

What is the future of the wet markets? Will they be multifunctional complexes? Or maintaining the status quo but with more stringent health and safety measures implemented? Will they be widely integrated with e-commerce? Or will they be more deeply rooted in communities with the empowerment of logistics? There is no doubt that it would be useful to formulate more standard norms, improve their pandemic prevention level, and gradually explore some more intelligent development directions through pilot projects.

5 Conclusion

In summary, this paper focuses on the food supply system in Wuhan during the pandemic and provides prescriptions for the system sustainability of cities in the post-pandemic period. From the perspective of the interaction between supply and demand entities and how it evolved, the research has found several critical points as follows. Firstly, the food supply system in Wuhan was characterized by simplification and differentiation in both supply and demand during the lockdown,
and this differentiation was the precise reason that the multiple interactions took place. Secondly, when the outbreak tremendously hit the food supply system, the government’s attempts to restore order through the establishment of designated road-markets eventually failed, before natural forces have shown their superiority. They were capable of bridging the gap between supply and demand, which has, to a large extent, eased the conflicts due to delay and mismatch. However, such informal organizations and behaviors required to be regulated and modulated, and potential security risks might be brought otherwise. For example, the ingredients obtained through WeChat group purchases were likely to have not been tested for food safety. Thirdly, we notice that the sudden outbreak of COVID-19 has also removed some specific groups of people out of the food supply system, as those stranded in Wuhan being the most prominent group. They were in extreme need of rapid and specialized assistance in the face of emergencies. Concerning the three different modes of organization (highly-organized, self-organized, and out-of-the-system), the entire food supply system is expected to be flexible enough to meet each type’s demand, supporting the benign interaction between formal forces and informal organizations.

This research also has some shortcomings. Limited by the pandemic situation, we failed to conduct field research in Wuhan. Although the amount of media data is quite considerable, the incompleteness of information remains. For example, how some specific subjects intervened in the food supply system hasn’t been investigated thoroughly. In addition, this paper mostly qualitative methods to obtain an overall understanding of the food supply system, and it may be useful to combine qualitative and quantitative methods in further research.
Reference


